

( )

**WHAT IS CLAIMED IS:**

1        1.        A method of performing downhole subsea wellbore operations utilizing a wellbore  
2        system having a tubing, a bottom hole assembly carried on the tubing adjacent the lower end  
3        thereof, a subsea wellhead assembly at the top of the wellbore receiving the tubing and  
4        bottom hole assembly, and a fluid return line extending from the wellhead assembly to the  
5        sea level, the method of drilling comprising:

6            (a)        positioning the bottom hole assembly in the wellbore below the wellhead  
7            assembly;

8            (b)        pumping a fluid down the tubing to the bottom hole assembly;

9            (c)        flowing wellbore return fluid through an annulus between the tubing and the  
10           wellbore to the wellhead and up the return line from the wellhead to the sea  
11           level, with the tubing, annulus, wellhead assembly and return line  
12           constituting a subsea fluid circulation system;

13           (d)        providing an adjustable pump system in fluid flow communication with said  
14           annulus; and

15           (e)        regulating the fluid pressure at the bottom of the borehole at predetermined  
16           values during downhole operations in the wellbore by operating the  
17           adjustable pump system to overcome at least a portion of the hydrostatic  
18           pressure and friction loss pressure of the return fluid.

- 1        2.        The method of claim 1 wherein regulating the fluid pressure in the borehole further  
2                comprises injecting a lower density flowable material than the return fluid into the  
3                fluid circulation system to assist the operation of the adjustable pump system in  
4                overcoming the hydrostatic and friction loss pressures of the return fluid.
- 1        3.        The method of claim 2 further comprising controlling the flow rate at which the  
2                lower density flowable material is injected into the return fluid.
- 1        4.        The method of claim 1 wherein regulating the fluid pressure in the borehole further  
2                comprises blocking flow of return fluid or the flow of fluid in the tubing when the  
3                adjustable pump system is not in operation.
- 1        5.        The method of claim 1 further comprising:  
2                (a)        sensing an operating parameter of the fluid circulation system indicative of  
3                the pressure or flow rate of the fluid in the fluid circulation system;  
4                (b)        transmitting a signal representative of the sensed parameter; and  
5                (c)        controlling the adjustable pump system at least in part based on said signal.
- 1        6.        The method of claim 1 wherein the pressure of the borehole is regulated at  
2                predetermined values below the fracture pressure of the formation.

1        7.        The method of claim 6 wherein the pressure of the borehole is regulated at  
2                predetermined values above the pore pressure of the formation.

1        8.        A wellbore system for performing subsea downhole wellbore operations at an  
2                offshore location comprising:

3                (a)        tubing receiving fluid under pressure adjacent the upper end thereof;

4                (b)        a bottom hole assembly adjacent the lower end of the tubing;

5                (c)        a subsea wellhead assembly at the top of the wellbore receiving the tubing  
6                                and the bottom hole assembly, said wellhead assembly adapted to receive said  
7                                fluid after it has passed down through said tubing and back up through an  
8                                annulus between the tubing and the wellbore;

9                (d)        a fluid return line extending up from the wellhead assembly to the sea level  
10                                for conveying return fluid from the wellhead to the sea level, with the tubing,  
11                                annulus, wellhead and return line constituting a subsea fluid circulation  
12                                system; and

13                (e)        an adjustable pump system in fluid communication with said annulus for  
14                                regulating the bottom hole pressure at predetermined values during downhole  
15                                operations in the wellbore to overcome at least a portion of the hydrostatic  
16                                pressure and friction loss pressures of the return fluid.

- 1        9.     The wellbore system of claim 8 further comprising:
  - 2            (a)     a source of flowable material having density lower than the density of the
  - 3                        return fluid; and
  - 4            (b)     an injector for injecting said flowable material into the return fluid during
  - 5                        downhole operations in the wellbore to assist the adjustable pump system in
  - 6                        pumping the return fluid.
  
- 1        10.    The wellbore system of claim 8 wherein said tubing is coiled tubing or jointed tubing.
  
- 1        11.    The wellbore system of claim 8 further comprising a flow control devices in the
  - 2                        subsea fluid circulation system, one device in the tubing or in communication with
  - 3                        the return fluid to block flow of fluid in the subsea fluid circulation system when the
  - 4                        adjustable pump system is not in operation.
  
- 1        12.    The wellbore system of claim 11 wherein said one flow control device in the tubing
  - 2                        is a remotely actuated choke for maintaining positive pressure of the fluid at the
  - 3                        surface.
  
- 1        13.    The wellbore system of claim 12 further comprising a transmitter at the surface for
  - 2                        sending an actuation signal to the choke, a receiver downhole for receiving the signal
  - 3                        and an actuator associated with the receiver for adjusting the choke.

1 14. The wellbore system of claim 8 wherein the adjustable pump system comprises a  
2 centrifugal pump.

1 15. The wellbore system of claim 8 wherein the adjustable pump system comprises a  
2 pump and a fluid by-pass line for maintaining the flow rate of fluid through the pump  
3 system generally constant with changes in the speed of operation of the pump.

1 16. The wellbore system of claim 8 further comprising:

2 (a) at least one sensor for sensing an operating parameter of the subsea fluid  
3 circulation system indicative of the pressure or flow rate of fluid in the fluid  
4 circulation system;

5 (b) a transmitter for transmitting a signal representative of the sensed parameter;  
6 and

7 (c) a controller for controlling the operation of the adjustable pump based at least  
8 in part on said signal.

1 17. The wellbore system of claim 9 wherein the injector is adjustable to control the flow  
2 rate at which the lower density material is injected into the return fluid.

1 18. The wellbore system of claim 8 wherein the return fluid flow is in a riser surrounding  
2 the tubing or in a return line separate and spaced apart from the tubing.

1        19.     A method of drilling a subsea wellbore utilizing a drilling system having tubing, a  
2        bottom hole assembly carried adjacent the lower end of the tubing, a subsea wellhead  
3        assembly at the top of the wellbore receiving the tubing and bottom hole assembly, and a  
4        fluid return line separate and spaced apart from the tubing extending from the wellhead  
5        assembly to the sea level, with the tubing, annulus, wellhead assembly and return line  
6        constituting a circulation system, the method of drilling comprising:

7            (a)     positioning the bottom hole assembly in the wellbore below the wellhead  
8            assembly;

9            (b)     pumping drilling fluid down the tubing to the bottom hole assembly;

10          (c)     flowing wellbore return fluid through an annulus between the tubing and the  
11          wellbore to the wellhead and up the return line from the wellhead to the sea  
12          level; and

13          (d)     regulating the fluid pressure in the borehole at predetermined values during  
14          downhole operations in the wellbore by injecting flowable material of a lower  
15          density than the return fluid to overcome at least a portion of the hydrostatic  
16          pressure and friction loss pressure of the return fluid.

1        20.     The method of claim 19 wherein regulating the fluid pressure in the borehole further  
2        comprises blocking flow of the return fluid in the circulation system or the flow of  
3        the drilling fluid in the tubing when the lower density flowable material is not being  
4        injected.

1        21.    The method of claim 19 further comprising:  
2            (a)     sensing an operating parameter of the fluid circulation system indicative of  
3                   pressure or flow rate of the fluid in the circulation system;  
4            (b)     transmitting a signal representative of the sensed parameter; and  
5            (c)     controlling the injection of lower density material at least in part based on  
6                   said signal.

1        22.    The method of claim 17 wherein regulating the fluid pressure in the borehole further  
2            comprises operating an adjustable pump system to assist the injection of lower  
3            density flowable material in overcoming the hydrostatic and friction loss pressures.

1        23.    The method of claim 19 wherein the pressure of the borehole is regulated at  
2            predetermined values below the fracture pressure of the formation.

1        24.    The method of claim 23 wherein the pressure of the borehole is regulated at  
2            predetermined values above the pore pressure of the formation.

1        25.    The method of claim 19 wherein the tubing is coiled tubing or jointed tubing.

1        26.    A drilling system for drilling a wellbore at an offshore location comprising:  
2            (a)     tubing receiving drilling fluid under pressure adjacent the upper end thereof;  
3            (b)     a bottom hole assembly adjacent the lower end of the tubing;

- (c) a subsea wellhead assembly at the top of the wellbore receiving the tubing and the bottom hole assembly, said wellhead assembly adapted to receive said fluid after it has passed through said tubing and through the annulus between the tubing and the wellbore;
- (d) a fluid return line separate and spaced apart from the tubing extending up from the wellhead assembly to the sea level for conveying said fluid from the wellhead to the sea level, with the tubing, annulus, wellhead and return line constituting a fluid circulation system;
- (e) a source of flowable material having a density lower than the density of the return fluid; and
- (f) an injector in fluid communication with the fluid circulation system for injecting said flowable material into the return fluid to maintain the bottom hole pressure at predetermined values during downhole operations in the wellbore to overcome at least a portion of the hydrostatic pressure and friction loss pressures in the return fluid.

27. The drilling system of claim 26 further comprising:

- (a) at least one sensor for sensing an operating parameter of the fluid circulation system indicative of the pressure or flow rate of the fluid in the fluid circulation system;
- (b) a transmitter for transmitting a signal representative of the sensed parameter; and



(c) a controller for controlling the operation of the injector based at least in part on said signal.

28. The drilling system of claim 26 further comprising at least one flow control device in the fluid circulation system to control the flow of the fluid in the fluid circulation system.

29. The drilling system of claim 26 further comprising at least two flow control devices in the fluid circulation system, one device in the tubing and the other in the fluid communication with the return fluid to block flow of fluid when the injector is not in operation.

30. The drilling system of claim 29 wherein said flow control device in the tubing is a remotely actuated choke for maintaining positive pressure of the drilling fluid at the surface.

31. The drilling system of claim 30 further comprising a transmitter at the surface for sending an actuation signal to the choke, a receiver downhole for receiving the signal and an actuator associated with the receiver for adjusting the choke.

32. The drilling system of claim 26 wherein the injector is adjustable to control the flow rate at which the lower density material is injected into the return fluid.

1        33.     The drilling system of claim 26 wherein said tubing is coiled tubing or jointed tubing.

1        34.     A wellbore system for performing downhole subsea operations in a wellbore at an  
2 offshore location, comprising:

3            (a)     tubing receiving fluid under pressure adjacent the upper end thereof;

4            (b)     a bottom hole assembly adjacent the lower end of the tubing;

5            (c)     a subsea wellhead assembly at the top of the wellbore receiving the tubing  
6 and the bottom hole assembly, said wellhead assembly adapted to receive said  
7 fluid after it has passed down through said tubing and back up through the  
8 annulus between the tubing and the wellbore;

9            (d)     a fluid return line separate and spaced apart from the tubing extending up  
10 from the wellhead assembly to the sea level for conveying return fluid from  
11 the wellhead to the sea level, with the tubing, annulus, wellhead and return  
12 line constituting a subsea fluid circulation system;

13          (e)     an adjustable fluid lift in fluid communication with the subsea fluid  
14 circulation system for regulating the fluid pressure at predetermined values  
15 during downhole operations in the wellbore by overcoming at least a portion  
16 of the hydrostatic pressure and friction loss pressures of the return fluid; and

17          (f)     a fluid surge vessel extending up from adjacent the wellhead to the surface  
18 and in fluid communication with return fluid from the annulus, said vessel  
19 holding a lower column of return fluid and an upper column of water with the

20 height of the column of return fluid indicative of the differential pressure of  
21 the return fluid and the sea water adjacent the wellhead.

1 35. The wellbore system of claim 34 further comprising a valve adjacent the wellhead  
2 to block fluid communication between return fluid from the annulus and the fluid  
3 surge vessel.

1 36. The wellbore system of claim 34 wherein the fluid surge vessel is a stand pipe.

1 37. The wellbore system of claim 34 wherein the tube receives the tubing and serves as  
2 a guide for the tubing.

1 38. The wellbore system of claim 34 further comprising a sensor for measuring a  
2 parameter indicative of the volume of water flowing into and out of the vessel, with  
3 changes in the pressure of the return fluid adjacent the wellhead.